MISB MOTION IMAGERY STANDARDS BOARD	MISB ST 1602
STANDARD	
Composite Imaging Local Set	**23 February 2017**

1 Scope

This standard defines a KLV metadata Local Set which enables a unique assignment of image-attribute metadata to several images composited into one image frame.

The standard supports image compositing such as: tiling of views from different sensors, blending of images, a stacked series of images, and picture-in-picture.

The standard applies to rectangular geometric images only; that is, rectangles-on-rectangles.

The standard assumes reuse of the Segment Local Set (see MISB ST 1607 [1]) within an instantiating metadata set.

The standard does not support dynamic overlays under direction of a client receiver.

2 References

[1] MISB ST 1607 Constructs to Amend/Segment KLV Metadata, 2016.

[2] MISB ST 0601.11 UAS Datalink Local Set, Feb 2017.

[3] MISB ST 0807.19 MISB KLV Metadata Registry, Feb 2017.

[4] MISB ST 0107.2 Bit and Byte Order for Metadata in Motion Imagery Files and Streams, Feb 2014.

[5] SMPTE ST 336:2007 Data Encoding Protocol Using Key-Length-Value.

[6] MISB ST 0603.4 MISP Time System and Timestamps, Feb 2016.

[7] MISB ST 0902.6 Motion Imagery Sensor Minimum Metadata Set, Feb 2017.

[8] MISB MISP-2017.2 Motion Imagery Standards Profile, Feb 2016.

[9] MISB ST 1202.2 Generalized Transformation Parameters, Feb 2015.

3 Terms, Acronyms and Definitions

KLV	Key-Length-Value
LS	Local Set
PIP	Picture-in-Picture

4 Revision History

Revision	Date	Summary of Changes
ST 1602	02/23/2017	Initial Release

5 Introduction

Image composition, as used in this document, is an arrangement of one or more images – possibly but not necessarily – derived from one or more sensors, combined into one image of Motion Imagery. Examples include: tiling of views from different sensors, blending of images, a stacked series of images, and picture-in-picture.

Whereas a typical Motion Imagery sequence is derived from one sensor source, the metadata to describe an image composed of more than one image (called sub-images) is more complex in structure. Each sub-image within the composite needs description of its unique attributes, such as its position with the composited image, the pixel density, the source for the sub-image, etc. This necessitates a distribution of metadata among the full composite and the various sub-images, in addition to each sub-image specific attribute metadata (i.e. position, pixel density, etc.).

The Composite Imaging Local Set provides this second category of image-specific attribute metadata. In typical use cases, the Composite Imaging Local Set will be embedded within the Segment Local Set described by MISB ST 1607 [1], which affords multiple instances of the Composite Imaging Local Set within one instantiating metadata set (e.g. MISB ST 0601 [2]). Example use cases are provided in the appendix.

6 Background

This section provides terminology and an orientation for proper application of the metadata elements within the Composite Imaging Local Set.

Composite Image: an image composed of several images derived from one or more sources of images within Motion Imagery.

Source Image: an image as produced by a Motion Imagery source, such as a sensor or camera.

Source Image AOI: Area of Interest, which represents a rectangular area with a Source Image used in defining a Sub-Image.

Sub-Image: an image derived from a Source Image. A Sub-Image may represent a processed version of its Source Image (i.e. same pixel density but different image characteristics), or an area of interest extracted from a Source Image, which may also have been further processed.

The pixel density of a Composite Image is independent of Source Images represented. The Composite Image can be considered a canvas onto which Source Images are mapped. A generalized representation of the mapping process is illustrated in Figure 1.

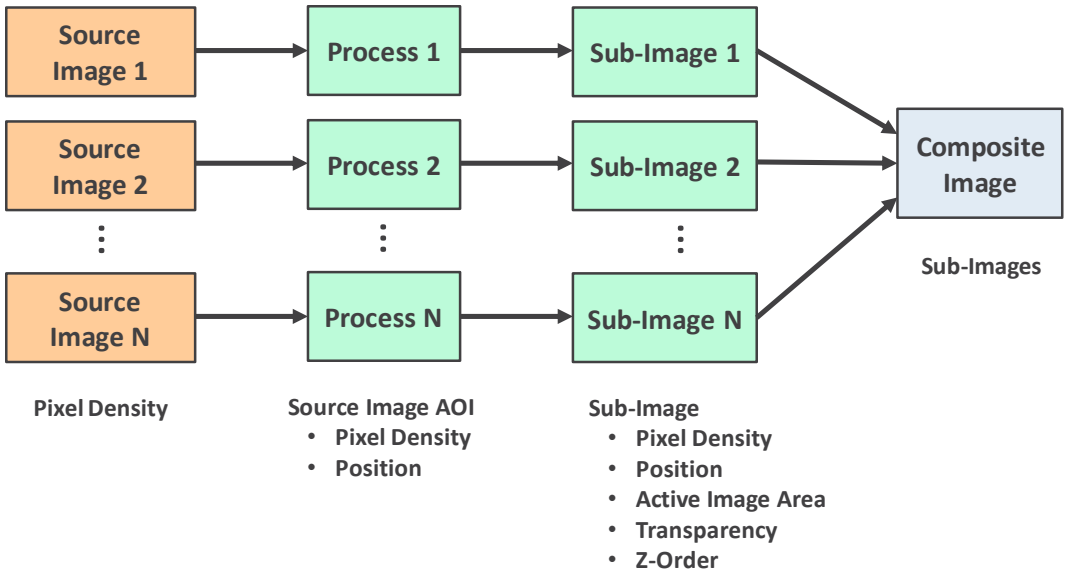


Figure 1: General mapping of multiple Source Images to Composite Image

Each Source Image in Figure 1 can undergo some process, such as color space conversion, bit-depth remapping, pixel density scaling, etc. prior to its placement within the Composite Image. Several parameters complete the mapping of a Source Image to the Composite Image. These include: A Source Image pixel's density specified as its number of rows and columns; an optional specification of the Source Image AOI rectangular region within the Source Image; and the Sub-Image produced using the Source Image AOI. A Sub-Image is specified with its pixel density (i.e. rows, columns), position within the Composite Image (i.e. position with respect to the upper left corner of the Composite Image), and optionally, the active area representing image content within the Sub-Image. A Sub-Image is qualified by its degree of transparency and it z-axis ordering. These parameters are discussed in more detail later.

Some elements within the Composite Imaging Local Set are mandatory; others depend on whether they are relevant to describing the mapping of a Source Image to the Composite Image.

7 Composite Imaging Local Set

The Composite Imaging Local Set is a KLV Local Set construct whose elements provide information specific to an image, such as position, pixel density, transparency, and Z-order.

The Composite Imaging Local Set 16-Byte Universal Label is registered in MISB ST 0807 [3] as:

06.0E.2B.34.02.0B.01.01.0E.01.03.03.02.00.00.00 (CRC 666)

The following rules apply to KLV metadata elements within the Composite Imaging Local Set:

Requirement(s)	
ST 1602-01	All KLV metadata shall be expressed in accordance with MISB ST 0107 [4].

ST 1602-02	The formatting of metadata elements within the Composite Imaging Local Set shall be compliant with SMPTE 336 [5] encoding rules for Universal Labels and Local Sets.

7.1 Local Set Elements

The Composite Imaging Local Set elements are listed in Table 1, which has the following column designations:

- **Tag ID** is the LS tag number for the element value.
- **Name** is the name of the dictionary element.
- **Key** is the SMPTE KLV registry key for the element from MISB ST 0807 [3].
- **Units** is the quantity of measure for the element.
- **Format** is the type of data for the element. Note: The Formats uint and int are generalized to allow the application to define the number of bytes needed for a values representation. The length is indicated by the "Length" of the KLV triplet.
- **Type** indicates whether the element is Mandatory or Optional in the Local Set.

Table 1: Composite Imaging Local Set

Local Set Key			**Name**		
06.0E.2B.34.02.0B.01.01.0E.01.03.03.02.00.00.00 (CRC 666)			Composite Imaging Local Set		
Constituent Elements					
Tag ID	**Name**	**Key**	**Units**	**Format**	**Type**
1	Precision Time Stamp	06.0E.2B.34.01.01.01.03.07.02.01.01.01.05.00.00 (CRC 64827)	Micro-seconds	uint64	OPTIONAL
2	Document Version	06.0E.2B.34.01.01.01.01.0E.01.02.05.05.00.00.00 (CRC 56368)	N/A	ber-oid	MANDATORY
3	Source Image Rows	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.00.00.00 (CRC 3468)	pixels	uint	OPTIONAL
4	Source Image Columns	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.01.00.00 (CRC 15036)	pixels	uint	OPTIONAL
5	Source Image AOI Rows	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.0A.00.00 (CRC 51789)	pixels	uint	OPTIONAL
6	Source Image AOI Columns	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.0C.00.00 (CRC 30957)	pixels	uint	OPTIONAL
7	Source Image AOI Position X	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.0D.00.00 (CRC 20445)	pixels	int	OPTIONAL
8	Source Image AOI Position Y	06.0E.2B.34.01.01.01.01.0E.01.01.03.40.0E.00.00 (CRC 5773)	pixels	int	OPTIONAL

9	Sub-Image Rows	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.02.00.00 (CRC 25580)	pixels	uint	MANDATORY
10	Sub-Image Columns	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.03.00.00 (CRC 21724)	pixels	uint	MANDATORY
11	Sub-Image Position X	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.04.00.00 (CRC 53580)	pixels	int	MANDATORY
12	Sub-Image Position Y	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.05.00.00 (CRC 59004)	pixels	int	MANDATORY
13	Active Sub-Image Rows	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.06.00.00 (CRC 48940)	pixels	uint	OPTIONAL
14	Active Sub-Image Columns	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.07.00.00 (CRC 34844)	pixels	uint	OPTIONAL
15	Active Sub-Image Offset X	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.08.00.00 (CRC 42029)	pixels	int	OPTIONAL
16	Active Sub-Image Offset Y	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.09.00.00 (CRC 37661)	pixels	int	OPTIONAL
17	Transparency	06.0E.2B.34.01.01.01.01. 0E.01.01.03.40.0B.00.00 (CRC 64893)	N/A	uint8	OPTIONAL
18	Z-Order	06.0E.2B.34.01.01.01.01. 0E.01.02.05.06.00.00.00 (CRC 18412)	N/A	uint8	MANDATORY

7.2 Element Details

7.2.1 Precision Time Stamp

MISB ST 0603 [6] defines the Precision Time Stamp. This element is mandated by the MISP within a Motion Imagery stream. The element is listed as Optional in the Composite Imaging Local Set because it is assumed to be present at the parent level set in which the Composite Imaging Local Set is embedded. The element may be included within the Composite Imaging Local Set in cases where a Source Image, or subsequent process, has a different timestamp than the parent timestamp. The use case will determine if additional timestamps are important to the application.

7.2.2 Document Version

The document version identifies the version of ST 1602 used in the implementation.

Requirement	
ST 1602-03	A Composite Imaging Local Set shall contain the Document Version metadata element.

7.2.3 Source Image Rows

Source Image Rows is the number of image samples in the vertical direction (i.e. image height) of the source image for the described sub-image. See Figure 2.

Figure 2: Source Image pixel density specified as Rows, Columns.

7.2.4 Source Image Columns

Source Image Columns is the number of image samples in the horizontal direction (i.e. image width) of the source image for the described sub-image See Figure 2.

7.2.5 Source Image AOI Rows

Source Image AOI Rows is the number of image samples in the vertical direction (i.e. image height) of the Source Image AOI. The Source Image AOI is the image used to create a Sub-Image of the Source Image. See Figure 3. In cases where the entire Source Image is mapped directly to its Sub-Image (i.e. Source Image AOI identical to the Source Image), this parameter is not necessary to specify.

7.2.6 Source Image AOI Columns

Source Image AOI Columns is the number of image samples in the horizontal direction (i.e. image width) of the Source Image AOI. The Source Image AOI is the image used to create a Sub-Image of the Source Image. See Figure 3. In cases where the entire Source Image is mapped directly to its Sub-Image (i.e. Source Image AOI identical to the Source Image), this parameter is not necessary to specify.

7.2.7 Source Image AOI X Position

Source Image AOI X Position is the x-coordinate in pixels defining the upper left corner of the rectangular area of interest in the Source Image referenced to the upper left (0, 0) corner of the Source Image. The Source Image AOI is the image used to create a Sub-Image of the Source Image. See Figure 3. In cases where the entire Source Image is mapped directly to its Sub-Image (i.e. Source Image AOI identical to the Source Image), this parameter is not necessary to specify.

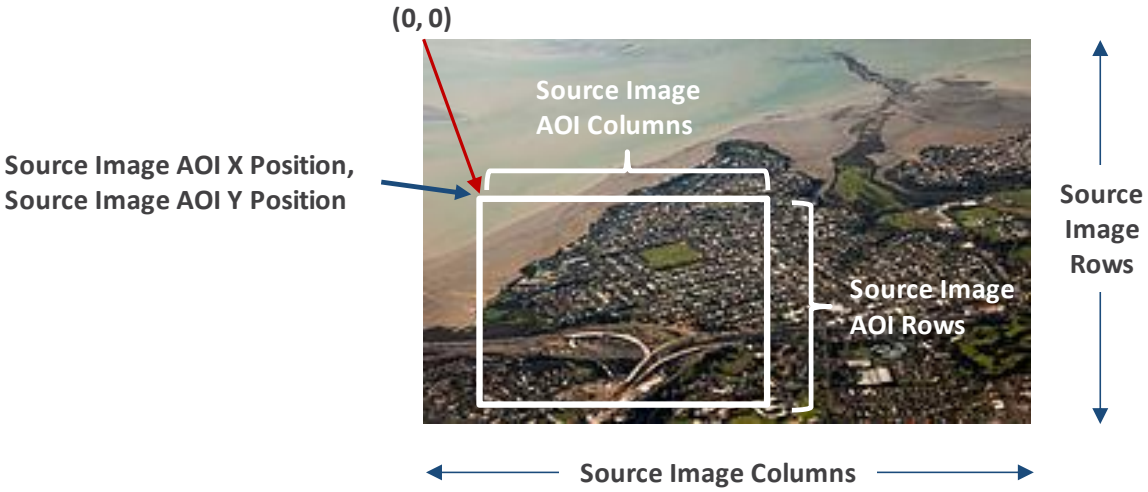


Figure 3: Source Image AOI position referenced to Source Image.

7.2.8 Source Image AOI Y Position

Source Image AOI Y Position is the y-coordinate in pixels defining the upper left corner of the rectangular area of interest in the Source Image referenced to the upper left (0, 0) corner of the Source Image. The Source Image AOI is the image used to create a Sub-Image of the Source Image. See Figure 3. In cases where the entire Source Image is mapped directly to its Sub-Image (i.e. Source Image AOI identical to the Source Image), this parameter is not necessary to specify.

7.2.9 Sub-Image Rows

Sub-Image Rows is the number of image samples in the vertical direction (i.e. image height) of the sub-image derived from its Source Image AOI. See Figure 4.

Figure 4: Source Image AOI used to create Sub-Image.

7.2.10 Sub-Image Columns

Sub-Image Columns is the number of image samples in the horizontal direction (i.e. image width) of the sub-image derived from its source image. See Figure 4.

7.2.11 Sub-Image Position X

Sub-Image Position X is the x-coordinate of the upper left corner of a Sub-Image referenced to the upper left corner, i.e. coordinates (0, 0) of the Composite Image. See Figure 5.

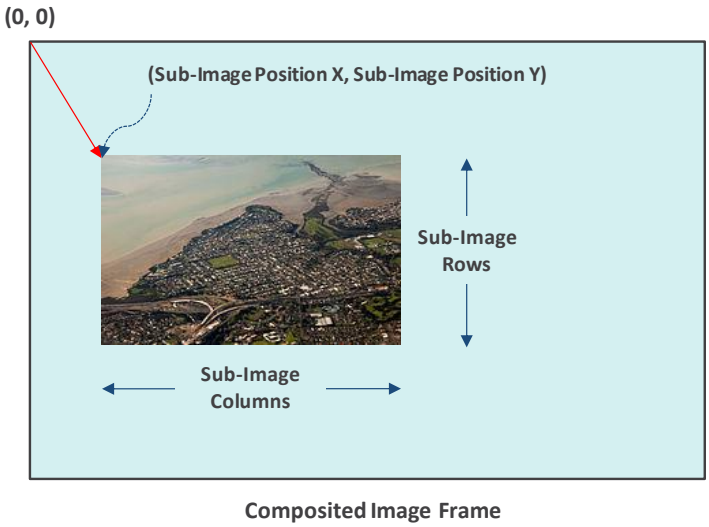


Figure 5: Relation of Sub-Image to Composite Image.

7.2.12 Sub-Image Position Y

Sub-Image Position Y is the y-coordinate of the upper left corner of a Sub-Image referenced to the upper left corner, i.e. coordinates (0, 0) of the Composite Image. See Figure 5.

7.2.13 Active Sub-Image Rows

Active Sub-Image Rows is the number of samples in the vertical direction representing Source Image content; that is, containing the portion of the Source Image of interest. See Figure 6.

7.2.14 Active Sub-Image Columns

Active Sub-Image Columns is the number of samples in the horizontal direction representing Source Image content; that is, containing the portion of the Source Image of interest. See Figure 6.

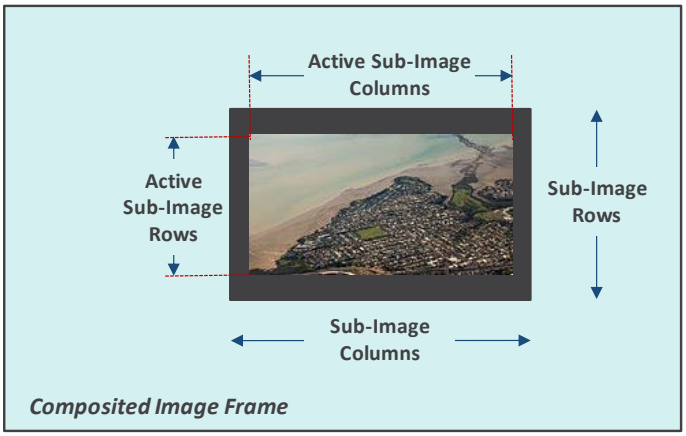


Figure 6: Active Sub-Image Area.

7.2.15 Active Sub-Image Offset X

Active Sub-Image Offset X provides the x-coordinate of the upper left corner of the active image within the Sub-Image referenced to Sub-Image Position X. See Figure 7, where x-coordinate = Sub-Image Position X + Active Sub-Image Position X.

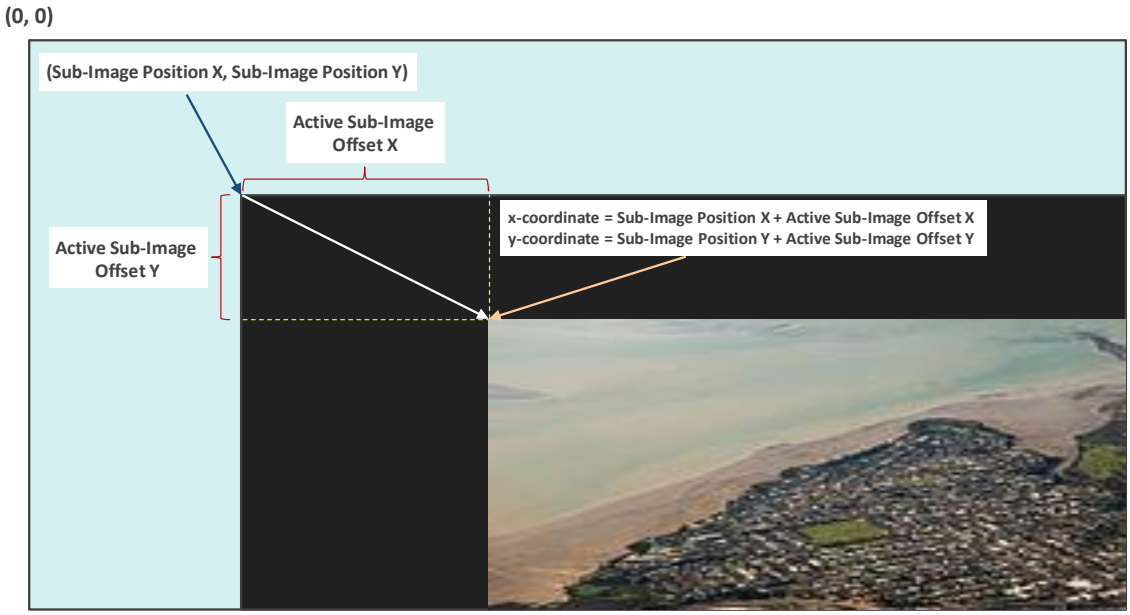


Figure 7: Relation of Active Sub-Image to Sub-Image.

Non-image areas, such as black borders when an image is letter-boxed, can be described by knowledge of the Sub-Image Rows/Columns, Sub-Image Position X/Y, Active Image Rows/Columns, and Active Sub-Image Offset X/Y.

7.2.16 Active Sub-Image Offset Y

Active Sub-Image Offset Y provides the y-coordinate of the upper left corner of the active image within the Sub-Image described by the Local Set referenced to Sub-Image Position Y. See Figure 7, where y-coordinate = Sub-Image Position Y + Active Sub-Image Position Y.

Non-image areas, such as black borders when an image is letter-boxed, can be described by knowledge of the Sub-Image Rows/Columns, Sub-Image Position X/Y, Active Sub-Image Rows/Columns, and Active Sub-Image Offset X/Y.

7.2.17 Transparency

The Transparency parameter provides 256 levels of image transparency. Consider two images A and B superimposed on top of one another as shown in Figure 8; denote image A as the background image and image B as the foreground image.

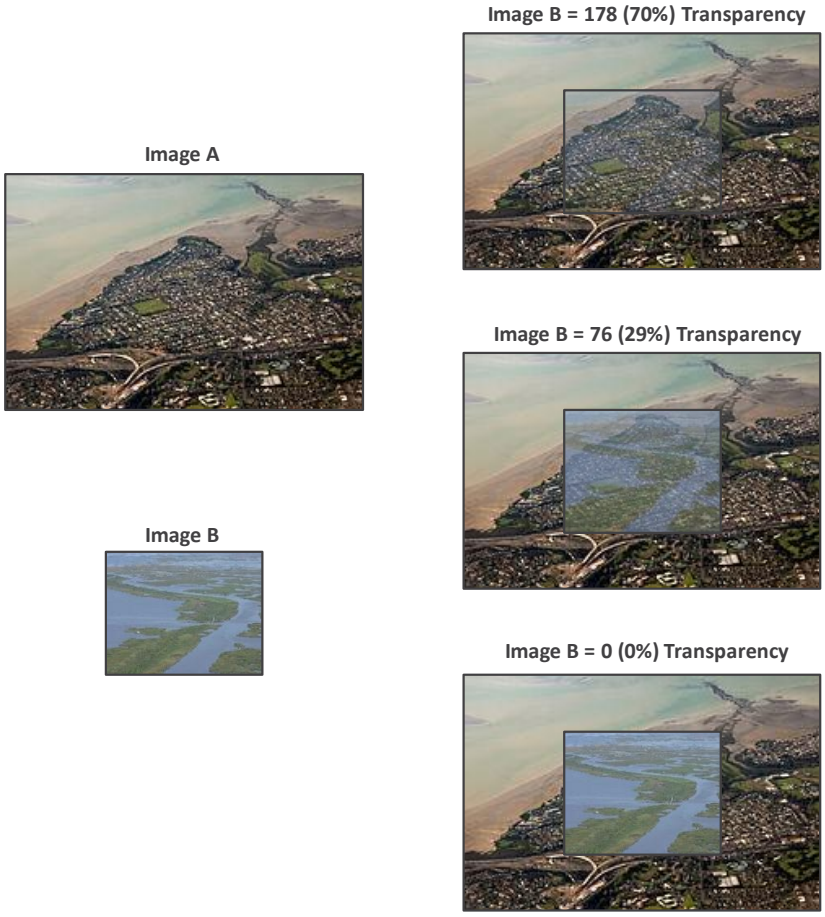


Figure 8: Images A and B superimposed using Translucency parameter.

A transparency value of zero (0) for Image B represents fully opaqueness, where image A is not visible and image B is fully visible. As the transparency value increases to 76 (29%) to 178 (70%), Image A becomes more visible. A transparency value of 255 represents full transparency, where image B is not visible and image A is fully visible. Values between zero and 255 represent levels of transparency for blending two images together. The default value for transparency is 0 when not included in the Local Set.

7.2.18 Z-Order

Z-Order defines the order of images (or stack) along the Z-axis (the axis perpendicular to the horizontal (left/right) axis, and the vertical (up/down) axis. A value of zero (0) is reserved for the bottom-most image in the stack. Different images cannot have the same z-order.

Requirement	
ST 1602-04	Each Sub-Image within a Composite Image shall have a unique non-zero Z-Order value.

8 Appendix A – Example: Four source images composited into one image - Informative

In this example, four independent sensors forming four Source Images are composited into one Composite Image as shown in Figure 9.

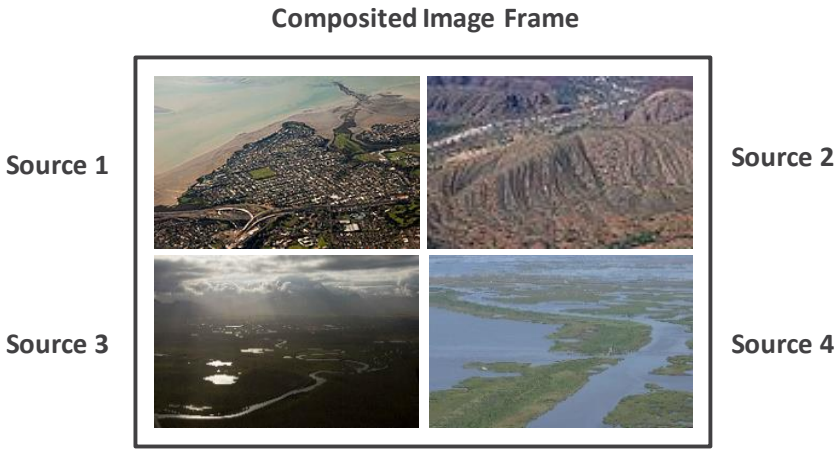


Figure 9: Four Source Images composited into one Composite Image.

The MISB ST 0902 [8] metadata elements are mandatory within Motion Imagery. In an image composed of four images, some elements are common across the four images, whereas, some elements are specific to each image themselves. For example, metadata is needed to describe the geometry of each image, such as location of each image within the composite, the pixel density of each image, etc. This information is provided in the Composite Imaging Local Set.

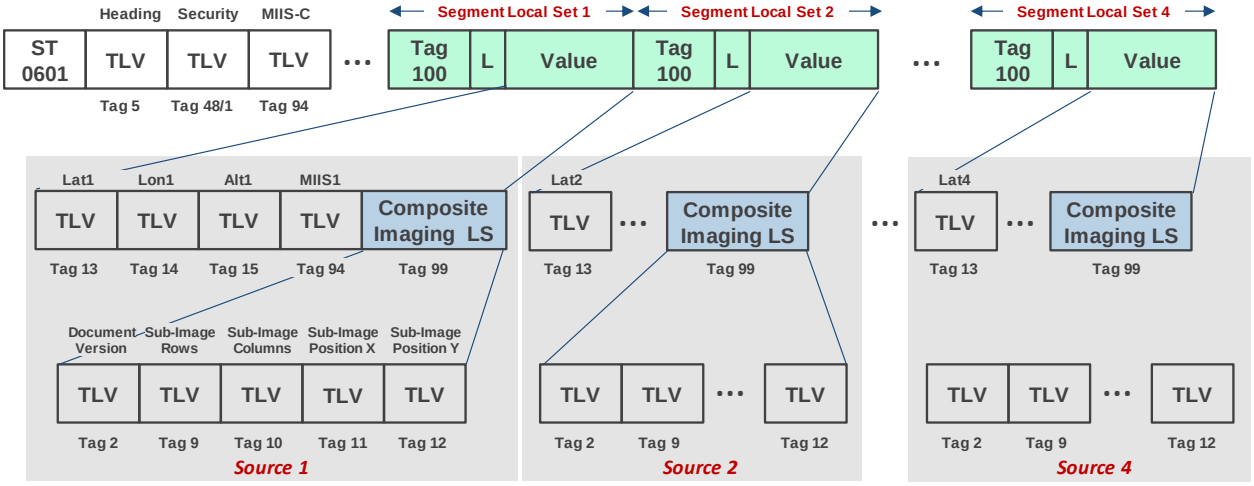
The Segment LS (Tag 100) in MISB ST 0601 enables reuse of those tags from MISB ST 0601 which are unique to a specific image. Because there are four source images, Tag 100 is reused four times. Within the Value of Tag 100, ST 0601 elements specific to each source image are inserted followed by a Composite Imaging Local Set (Tag 99) as shown in Figure 10.

Note that the MISB ST 0601 Tag13/Lat, Tag 14/Lon, and Tag 15/Alt are reused within Tag 100 as they describe the specific attributes of each sensor. Since each sensor has its own Motion Imagery Core Identifier (MI IS/Tag 94), that element is carried within the value of Tag 100 as well. Finally, the Tag 99 Composite Imaging Local Set is included, which carries specific attributes for each source image.

Most MISB ST 0601 tags are permitted within the Value of the Segment LS Tag 100. Exceptions include some elements of the Security Local Set Tag 48 (see MISB ST 1607 for these exceptions). While there is no requirement that any ST 0601 tags be present; the MISP [9] mandates a Motion Imagery stream contain all MISB ST 0902 elements. It is likely that some common MISB ST 0902 elements (i.e. mission, security, etc.) will be present at the MISB ST 0601 parent level, and others, which vary per sensor source, will be present at the Tag 100 child level.

Note in this example five Motion Imagery Core Identifiers (MIIS) are needed: one defining the composite image (i.e. MIIS-C) and one for each of the four sub-images (i.e. MIIS 1, MIIS 2, etc.).

Additional details on the use of the Segment LS construct can be found in the MISB ST 1607 [1].



Note: only a sample of required tags are shown

Figure 10: Use of Tag 100 – Embedding a Composite Imaging Local Set.

9 Appendix B – Example: Two source images composited into one blended image - Informative

In this example, two independent sensors forming two Source Images are blended together into one Composite Image as shown in Figure 11.

Figure 11: Two Source Images blended together.

The MISB ST 0902 metadata elements are mandatory within Motion Imagery. In an image composed of two images, some elements are common across the two images, whereas, some elements are specific to each image themselves. For instance, assuming both images have similar dimensions and location in the composite, specific metadata is needed to describe the transparency of each image. This information is provided by Transparency (Tag 17) in the Composite Imaging Local Set, which is present for each image.

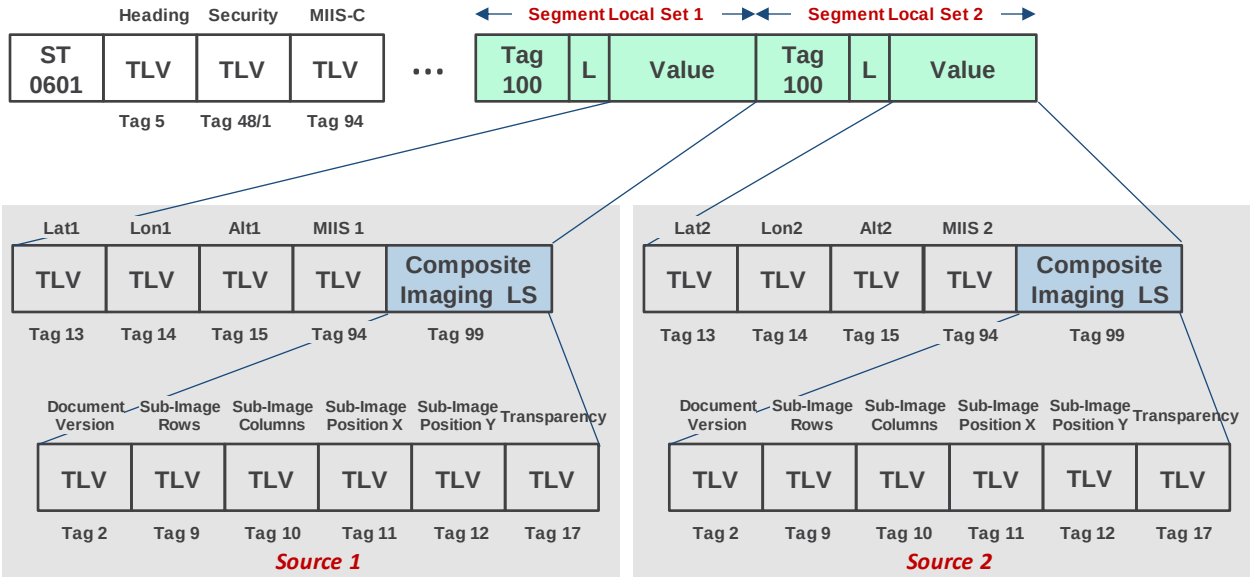
Each image in this example reuses four MISB ST 0601 tags. The Segment LS (Tag 100) in MISB ST 0601 enables the reuse of tags defined in a Local Set. Because there are two source images, Tag 100 is used twice. Within the Value of Tag 100, the four elements from MISB ST 0601 specific to each source image are inserted followed by a Composite Imaging Local Set Tag 99 as shown in Figure 12.

Note that the ST 0601 metadata Tag13/Lat, Tag 14/Lon, and Tag 15/Alt are reused within Tag 100 as they describe the specific attributes of each sensor. Since each sensor has its own Motion Imagery Core Identifier (MIIS/Tag 94), that tag is carried within Tag 100 as well. Finally, the Tag 99 Composite Imaging Local Set is included, which includes the specific attributes of each source image.

Some “common” MISB ST 0601 tags (i.e. mission, security, etc.) will be present at the parent level, and others, which vary per sensor source, will be present at the Tag 100 child level.

Note in this example three Motion Imagery Core Identifiers (MIIS) are needed: one defining the composite image (i.e. MIIS-C) and one for each of the four sub-images (i.e. MIIS 1, MIIS 2).

Additional details on the use of the Segment LS construct can be found in MISB ST 1607 [1].



Note: only a sample of required tags are shown

Figure 12: Two Source Images blended together.

10 Appendix C – Example: One source image with picture-in-picture composited into one image - Informative

In this example, one sensor provides the information for two image views: the main sensor Source Image and a picture-in-picture (PIP) zoomed view of an area-of-interest of the Source Image as shown in Figure 13.

Figure 13: One Source Image with PIP composited into one Composite Image.

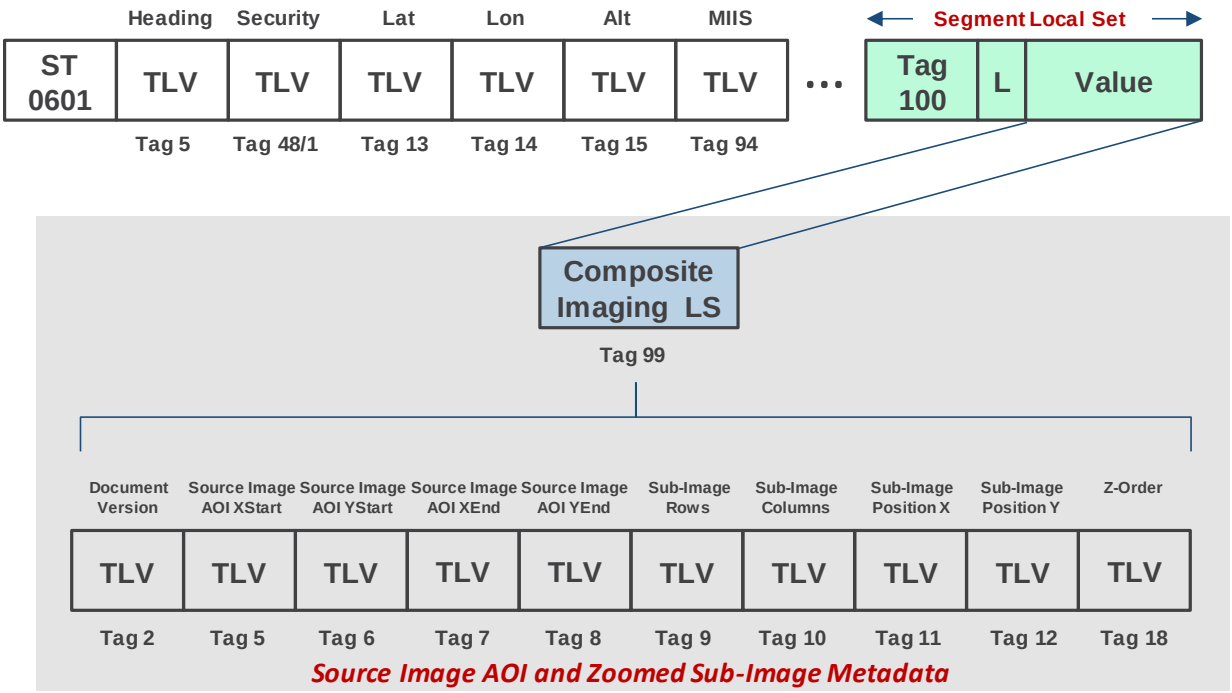
In this case, since both images emanate from the same source, all MISB ST 0902 metadata elements are common to both. Two Composite Imaging Local Sets describe the position/dimensions of the AOI extracted, and the position/dimensions of the zoomed Sub-Image.

It is likely that the Source Image AOI may change during the Motion Imagery sequence, the zoom factor varied, or the zoom turned off. Because of the temporal capability of this feature, the Segment LS (Tag 100) from MISB ST 0601 is used. As changes as those mentioned occur, the information described by Tag 100 will change as well; that is, the Composite Imaging Local Set contained within the value of Tag 100 will have differing metadata values.

Image transformations such as zoom can be effected using MISB ST 1202 [10]. Once the zoomed image is available and ready for compositing with the source image, the Composite Imaging Local Set provides the information for position/dimensions of both the Source Image AOI and the zoomed Sub-Image result. This is shown in Figure 14.

Note in this example, because the Source Image AOI and its derivative zoomed Sub-Image both emanate from the same source image, only one Motion Imagery Core Identifier (MIIS) is required in the metadata stream.

Additional details on the use of the Segment LS construct can be found in MISB ST 1607 [1].



Note: only a sample of required tags are shown

Figure 14: One Source Image with PIP zoomed Sub-Image overlay.